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BULLETIN
OF
THE UNIVERSITY OF TEXAS
NO. 327
OFFICIAL SERIES NO. 99 APRIL 5, 1914

Manual Training in the High School

BY

O. A. HANSZEN
ADJUNCT PROFESSOR OF MANUAL TRAINING
AND
ASSISTANT VISITOR OF SCHOOLS

Monograph

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The benefits of education and of useful knowledge, generally diffused through a community, are essential to the preservation of a free government.

Sam Houston.

Cultivated mind is the guardian genius of democracy. . . . It is the only dictator that freemen acknowledge and the only security that freemen desire.

Mirabeau B. Lamar.

D. of D.
JAN 26 1915

INTRODUCTION

There is a widespread and growing demand, in this country, for manual training and industrial education. This demand is an effort to meet some of the fundamental educational needs of our school system and the social need for a larger number of intelligent trained workers for the industries. It has resulted in the teaching of a variety of the manual or mechanic arts and in the development of a number of systems of instruction. Almost all of the large cities in every State have spent large sums for buildings and equipment in order to meet the demand. The work in these centers is thoroughly organized, and the excellent results thus far attained have fully justified the large expenditures.

In order to extend the benefits of instruction in manual training to more schools, legislation to encourage and assist schools undertaking this work, has been enacted in many of the States.

The Texas Legislature has aided the public schools, by appropriating money to supplement the funds raised by local means. It has also provided for the training of teachers of manual training, in the higher educational institutions of the State. The University of Texas is assisting in the spread and development of the work, not only by offering courses in manual training for teachers, but by granting entrance credits for the work done in the affiliated high schools. In many parts of the State plans are being made for the introduction of manual training into the public school course, or for the extension and development of the work already started. But the lack of proper information makes it difficult for the superintendent and school boards to plan wisely. The few well organized and successful large manual training high schools are taken as guides by many of the smaller schools introducing the work. Copying in detail the systems, the equipment, and the course of study of these large schools, does not avoid serious mistakes, since careful adjustment to local conditions and to the needs of the community must be made if this new part of the school work is to succeed. Some of the adjustments cannot be made until after the work is pretty well organized and in operation, but some phases of the problem must be solved before the equipment is purchased, and in many cases this has to be done before a com-

petent teacher can be secured. It is the purpose of this bulletin to supply such information concerning courses of study, equipment, space required, etc., as is needed by superintendents organizing departments of manual training; also to indicate the best lines along which to develop and improve the course of study and instruction.

COURSES OF STUDY

In the organization of the manual training department in the high school, much care should be exercised in planning or in selecting a course of study. Upon the course adopted will largely depend the amount and the shape of floor space, the number and character of rooms, the kind of equipment, the special training of the teacher, and other important elements.

It is doubtful if there could be outlined, at this time, courses which would satisfactorily meet the needs of all schools in the State. These needs differ not only with different types and grades of schools, but with the particular locality and community. The following courses, it is believed, will serve as safe guides to a large majority of the public high schools. The course in Group I is recommended for rural high schools, those in Group II for high schools in medium sized cities having no extensive manufacturing industries, and the course in Group III for schools in large cities and for schools in manufacturing centers.

GROUP I.

Two-Year Course.

DRAWING.

First Year.—Freehand projection sketches, from objects and from details of buildings and furniture. Use of instruments. Lettering. Geometric constructions. Working drawings.

Second Year.—Working drawings of farm building details, furniture problems, or useful farm projects. Sketching of machine details from objects. Perspective sketches from projection drawings.

SHOPWORK.

First Year.—Bench woodwork. A., 1 to 6. Carpentry applied to concrete forms and frame buildings. D, 1 and 2a. Concrete construction.

Second Year.—Carpentry applied to farm buildings, D, 2a and b, or benchwork, A. 5 to 9 and B, 1 to 3, and simple furniture

problems, C, 1 to 3. Forging, 1 to 9, 13. Simple sheet metal work, 1 to 3.

Note.—The figures and letters following subjects refer to the detailed outlines and indicate the amount of work to use.

GROUP II.

Two-Year Course.

DRAWING.

First Year.—Freehand projection sketches from objects. Use of instruments. Geometric constructions. Scale working drawings. Freehand lettering. Tracing.

Second Year.—Perspective sketches from projection drawings. Furniture details. Orthographic projections. Elementary architectural drawings. Original cottage plans and elevations.

SHOPWORK.

First Year.—Bench woodwork. Wood finishing.

Second Year.—Advanced bench woodwork. Problems in furniture construction, 1 to 3.

Three-Year Course.

The first and second year of this course should be the same as the first and second year of the two-year course except that turning should be included in the second year's work.

DRAWING.

Third Year.—Intersections. Developments. Sketching of machine parts. Geometric curves. Architectural or machine drawing.

SHOPWORK.

Third Year.—Forge work, 1 to 13. Sheet metal work. Machine shop work, A to D.

GROUP III.

Four-Year Course.

DRAWING.

First Year.—Freehand projection sketches from objects. Use of instruments. Geometric constructions. Scale working draw-

ings. Conventional representation of materials. Freehand lettering. Tracing. Principles of decorative design.

Second Year.—Perspective sketching from orthographic projections. Furniture details and working drawings. Orthographic projections. Use of water colors. Isometric and oblique drawing. Elementary architectural drawing. Original cottage plans and elevations.

Third Year.—Intersections. Developments. Higher geometric curves. Architectural or machine details.

Fourth Year.—Shades and shadows. Line shading. Perspective. Drawing for reproduction. Choice of architectural or machine drawing.

SHOPWORK.

First Year.—Bench woodwork. Problems in simple furniture construction, C, 1 to 2. Wood finishes.

Second Year.—Turning. Choice of: Art metal work, A and C, and problems in furniture construction, 2 to 4; or, Pattern making and moulding.

Third Year.—Forging. Choice of: Art metal and sheet metal work; or, Pattern making, moulding and foundry practice.

Fourth Year.—Machine shop work.

TIME REQUIRED.

The amount of time that should be given to each of the subjects suggested in the preceding outlines of courses cannot be determined except by trial in each particular school. The previous training and experience of the pupils, the standard of work demanded by the teacher, and the character of the material used, will largely determine the apportionment of the time available for the work.

As considerable time at the beginning of the laboratory period must be used in preparing for the work, and as considerable time at the close of the period must be used in cleaning up and setting things in order, this extra time amounting in many cases to as much as fifteen minutes, each laboratory lesson should be given a double period, or about ninety minutes.

Many of the most valuable problems require a number of hours for completion, and when this time is divided into short and scat-

tered periods the pupil's interest is sure to lag, and much of the instruction given is forgotten before it can be applied. It is therefore recommended that at least two periods of 90 minutes each be devoted to shopwork and an equal amount to drawing each week. The University is offering ½ or 1 unit of credit for manual training (shopwork) and ½ or 1 unit of credit for drawing. In order to obtain one unit of credit in either of these subjects, the amount of time devoted to the subject must be at least five periods of 80 minutes each per week for thirty-six weeks, or the equivalent of this time may be spread over two years of the high school.

Table No. 2, immediately following, is given to show how a few of the well organized schools have apportioned the time devoted to shopwork and drawing.

Table No. 2.

Total number of hours devoted to drawing and to shopwork, and number of lessons for each topic:

Column A gives the number of lessons. Column B gives the total number of hours.	Austin High School		Bonham High School		Dallas High School		Ft. Worth High School		Houston High School		San Antonio High School		Waco High School	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
FIRST YEAR.														
Drawing	90	135	36	54	90	135	90	150		48		120	180	135
Sketching					24						10		45	34
Lettering	30	45	6	9	12				3	5	10		20	15
Geometrical problems	15	23	15	23	12		15	25	15	23	24		15	11
Working drawings	45	68	15	23	24		50	83	14	21	45		95	71
Conventional representations							15	25					5	4
Shopwork	90	135		81	90	135	90	150	36	54		162	180	135
Bench wood work	60	90	40	60	45	63	45	75	3	5	36		150	112
Furniture problems	30	45	14	21	45	62	45	75	33	49	72		30	22
SECOND YEAR.														
Drawing	90	135	36	54	90	135	90	150		108		120	180	135
Conventional representations												10		
Working drawings			5	8			45	75	6	9			45	34
Orthographic projections	45	68	31	46	47				64	96	45			
Isometric and oblique drawing	15	23			26		30	50			15			
Lettering	15	23							2	3	10		20	15
Shopwork	90	135	54	81	90	135	90	150	108	162		162	180	135
Bench work and joinery			25	38										
Furniture problems			29	44	90	135	90	150					180	135
Turning	45	68							54	81	54			
Art metal	45	68												
Pattern making and moulding									54	81	54			
THIRD YEAR.														
Drawing	90	135	36	54		90	90	150	72	108		120	180	135
Interseetions and developments	30	45	30	45	30	45					45		90	67
Higher geometric curves					30	45	30	50			10		10	8
Architectural drawing	60	90									45			
Machine drawing			6	9			60	100	72	108	or 45			
Shopwork	90	135	54	81		180	90	150	108	162		162	180	135
Forging	90	135			60	90	90	150	100	150	108			
Sheet metal work									8	12				
Pattern making and moulding					60	90								
Turning			54	81									180	135
FOURTH YEAR														
Drawing	90	135	36	54	90	135	90	150	72	108		120	180	135
Line shading					5	8	5	8			5			
Shade and shadows					40	60	10	17			20			
Perspective					20	30	15	25			20		20	15
Architectural drawing	90	135			25	37	60	100	72	108	45		160	120
Machine drawing			36	54	or 25						or 45			
Shopwork	90	135	54	81	90	135	90	150	108	162		162		
Pattern making			54	81										
Machine shop practice	90	135			90	135	90	150	108	162	108			

EQUIPMENT

Many factors enter into the selection of the hand tools, machines, and furniture for the manual training laboratories. The course of study, the class unit, the available motive power, and the cost, are the important factors.

Two types of equipment are suggested in the following list, one of very fine quality and elaborate enough to meet the most exacting demands, the other of medium quality and extensive enough to meet the demands of the small school. The equipments have been planned for class units small enough to make possible a high degree of efficiency.

The prices given, except those marked "*," are from quotations made by the following firms:

Walter Tips, Austin, Texas.

Huey & Philp Hardware Co., Dallas, Texas.

Behering & Cartes Hardware Co., Houston, Texas.

Prices marked "*" are given by the manufacturer. All prices are for goods F. O. B. point of shipment and are correct at the present date (1914). Prices in the first column are the lowest, and those in the second are the highest quoted.

Orders for complete equipments are generally subject to special discounts, hence it is suggested that schools submit to these firms their lists of equipment for prices before ordering.

EQUIPMENT FOR COURSES IN GROUP I.

Minimum Equipment for Woodwork for Class of 12.

INDIVIDUAL TOOLS.

12 try-squares, 7½ inches, Stanley's No. 20	$ 1.60	$ 2.29
12 two-foot rules, Stanley's No. 1, two fold	1.73	2.00
12 marking gauges, Stanley's No. 65	2.99	3.00
12 jack planes, 14 inches, Bailey's No. 5C, or Sargent's V. B. M. No. 14	19.80	22.64
6 tanged firmer chisels, ½ inch, Buck Bros.' No. 30	2.40	2.50
6 tanged firmer chisels, 1 inch, Buck Bros.' No. 30	2.83	3.13
6 cabinet saws, Disston's No. 80, 14 inches	3.75	3.88
6 panel saws, 22 inches, 9 points, Disston's No. 8	6.35	7.15
12 spoke shaves, Stanley's No. 54	*4.72	4.72

6 hickory mallets, 4x3 inches	.69	.88
6 bench dusting brushes, Bromwell's No. 502, 8 inches	1.25	1.25
12 single work benches, No. 1, with Wilcox vise 230S, No. 1, see page 15, estimate	144.00	144.00
Or 6 double work benches, same structural design as No. 1, estimated cost	120.00	120.00
	$193.31	$197.64

GENERAL EQUIPMENT.

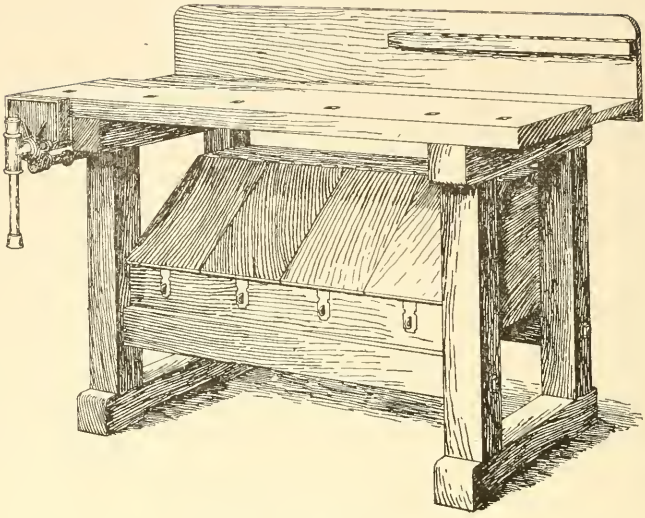
1 steel square, Sargent's No. 500, V. G. R.	$ 1.20	$ 1.25
1 steel square, Sargent's No. 3, V. G. R.	*1.00	1.00
1 adjustable plumb and level, 24 inches, Stanley's No. 30, duplex	1.05	1.10
2 metal T-bevel, 6 inches, Stanley's No. 18. Or Sargent's No. 66, $1.10.	.65	.67
1 folding rule, 6 feet, Stanley's zigzag, No. 706	.23	.25
1 extension dividers, 10 inches, Sargent's No. 51	.52	.52
1 extension dividers, 6 inches, Sargent's No. 51	.39	.39
2 socket mortise chisels, $\frac{1}{4}$ inch, Buck Bros.' No. 48	1.35	1.35
2 smoothing planes, Stanley's Bed Rock, No. 603 Or Sargent's No. 9.	3.00	3.06
1 fore plane, 20 inches, Stanley's No. 129	1.08	1.15
1 block plane, Stanley's No. 140	.92	.94
2 drawing knives, 6 inches, D. R. Barton's No. 85 (or P. S. W., $1.10)	1.80	1.80
1 shingle hatchet, Plum's No. 591 (or Sargent's No. 201, *90c)	.55	.55
2 hand saws, 26 inches, 7 points, Disston's No. 8	2.66	2.69
1 rip saw, 28 inches, 5 points, Disston's No. 8	1.50	1.53
1 rip saw, 26 inches, 6 points, Disston's No. 8	1.33	1.33
1 compass saw, 12 inches, 12 points, Disston's No. 2	.28	.28
2 coping saws, Miller Falls No. 40	.43	.50
1 miter box and saw, New Landon, No. 17	6.25	6.40
1 saw set, Monarch, No. 2, medium	.75	.75
1 saw clamp, Disston's No. 1	.63	.75

1 ratchet brace, 8-inch sweep, Barber's No. 733, or Stanley's No. 921	1.35	1.35
1 ratchet brace, 10-inch sweep, Barber's No. 732A (or Stanley's No. 921, $1.50)	1.75	1.75
9 auger bits, 3 each, $\frac{1}{4}$ inch, $\frac{3}{8}$ inch, $\frac{1}{2}$ inch, R. Jennings	2.16	2.38
4 auger bits, 2 each, $\frac{5}{8}$ inch, $\frac{3}{4}$ inch, R. Jennings	1.45	1.52
2 auger bits, 1 each, $\frac{7}{8}$ inch, 1 inch, R. Jennings	.96	1.00
6 gimlet bits, 2 each, 4/32, 5/32, 6/32, Sargent's double cut	.41	.41
1 Rose counter sink, Sargent's	.10	.17
1 screwdriver bit, D. R. Barton's or Buck Bros.'	.15	.20
1 expansion bit, Clark's No. 1 (or Sargent's No. 81, $1.00)	.60	.75
1 set nail sets, Goodell's No. 90	.84	.84
2 screwdrivers, 4 inches, Champion (or Sargent's No. 66, 50c)	.33	.36
1 screwdriver, 6 inches, Champion, or Sargent's No. 66	.25	.25
1 monkey wrench, 8 inches, S. R. & W. (or Sargent's No. 77, 25c)	.42	.42
3 adze-eye claw hammers, Maydole or Stanley's No. 12, 13 ounces	1.14	1.38
4 India oil stones in iron box, No. 0, medium	4.40	4.40
4 steel oilers, P. W. Mfg. Co.'s No. 304, $\frac{1}{2}$ pint.	.40	.45
1 pair steel bar adjustable clamps, 3 feet, Cincinnati Tool Co.'s Special Perfection	*2.80	2.80
3 pairs, steel spindle, Peerless, hand screws, 10 inches, Oliver's No. 913	*2.16	2.16
1 Stanley dowling gig, No. 59	1.30	1.35
1 tool grinder, Pike Peerless Senior, No. 9 (or Pike Greyhound, No. 15, $9.00)	5.25	5.50
1 kerosene glue heater, 1 quart, Oliver Model S. I. (or electric glue heater, Oliver R. J., $14)	*7.00	7.00
	$ 62.79	$ 64.70

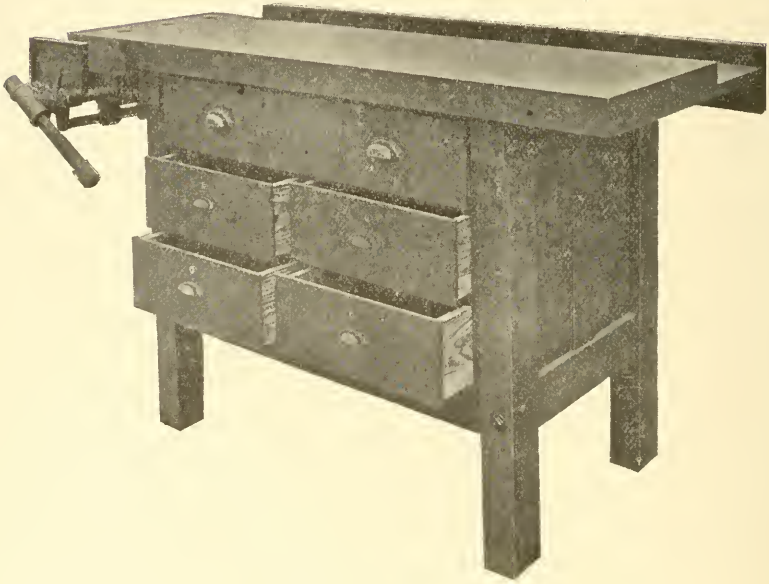
Complete Equipment for Woodwork for Class of 12.

INDIVIDUAL TOOLS.

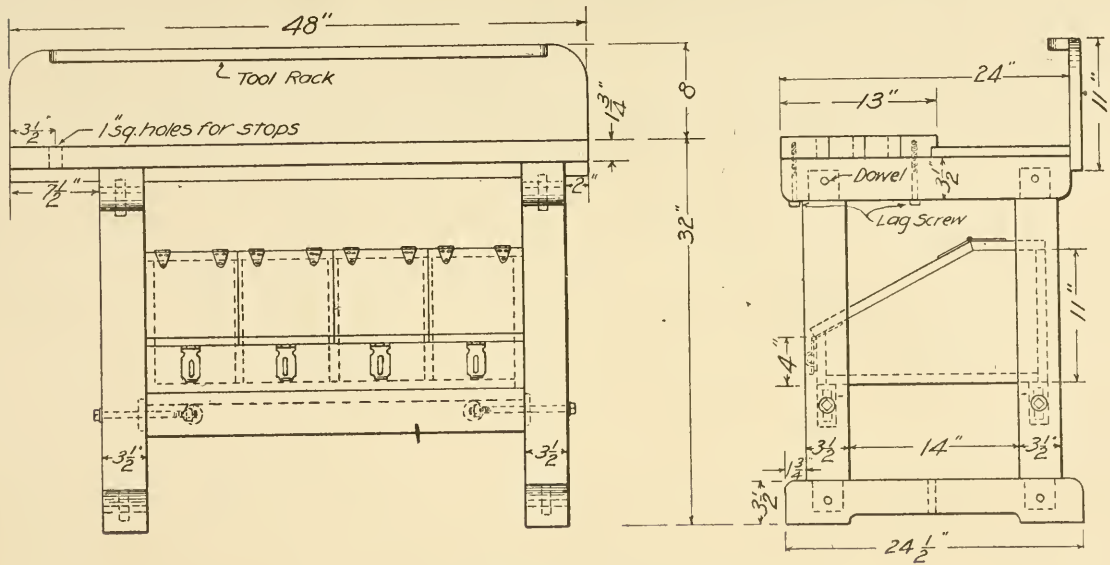
12 try-squares, 8 inches, Disston's No. 15 or Stanley's No. 10	$ 3.25	$ 5.50
12 two-foot rules, Stanley's No. 1, two fold	1.73	2.00
12 marking gauges, Stanley's No. 77	5.50	5.60
12 jack planes, 14 inches, Stanley's Bed Rock, No. 605, or Sargent's V. B. M., 14	22.80	23.40
12 tanged firmer chisels, ¼ inch, bevel back, Buck Bros.' No. 30	4.40	4.40
12 tanged firmer chisels, ½ inch, bevel back, Buck Bros.' No. 30	4.80	5.00
12 tanged firmer chisels, 1 inch, bevel back, leather tipped handle, Buck Bros.' No. 30	5.65	6.25
12 cabinet saws, Disston's No. 80, 14 inches	7.50	7.75
12 panel saws, 22 inches, 9 points, Disston's No. 112	19.00	19.50
12 sloyd knives, 2½ inches, Dexter D. or H. & S. Co.	2.16	2.40
12 spoke shaves, Stanley's No. 54	4.70	4.70
12 India oil stones, No. 0, in iron boxes	13.20	13.20
12 maple bench hooks, Orr & Lockett	*3.00	3.00
12 adze-eye claw hammers, 7 ounces, Maydole	4.25	5.00
12 lignumvitae mallets, No. 5, 3x5 inches	2.70	3.50
12 bench brushes, Bromwell's No. 402, 8 inches	7.00	7.25
12 single work benches, No. 2 (see page 16), estimate	192.00	200.00
Or Grand Rapids Hand Screw Co.'s bench, No. 96, $202.		
	$303.64	$318.45



Work Bench No. 1.



Work Bench No. 2.



WORK BENCH NO. I

SCALE $\frac{3}{4}$"=1 FT.

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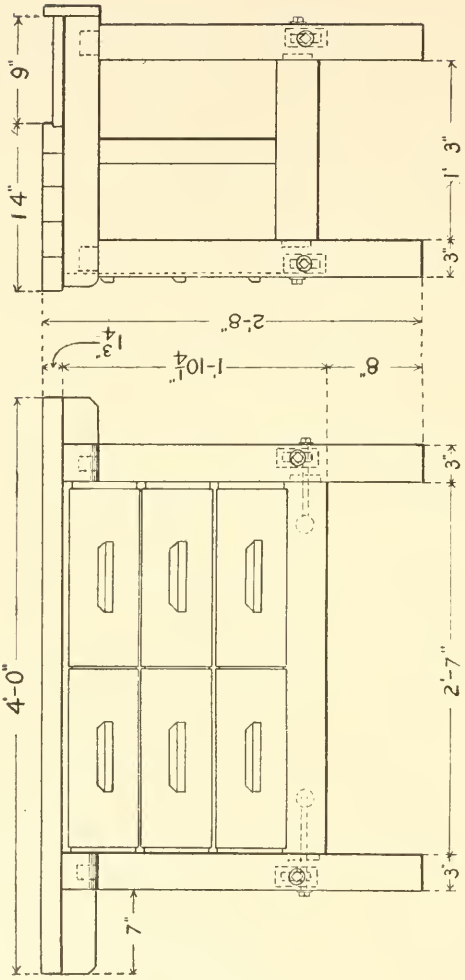


WORK BENCH NO. 2

Scale $\frac{3}{4}$" = 1 Ft.

V. K. S

GENERAL EQUIPMENT.

2 steel squares, Sargent's No. 500, V. G. R....	$ 2.40	$ 2.50
1 steel square, Sargent's No. 3, V. G. R.....	*1.00	1.00
1 steel square, Sargent's No. 12, V. G.....	*.85	.85
1 metallic plumb and level, 24 inches, Stanley's No. 37G	1.19	2.27
3 metal T-bevels, 6 inches, Stanley's No. 18... Or Sargent's No. 66, $1.65.	.97	1.00
1 panel gauge, 20½ inches, Stanley's No. 85½...	.90	.96
1 folding rule, 6 feet, Stanley's No. 756.....	.24	.26
3 extension dividers, 6 inches, Sargent's No. 51	1.17	1.17
1 extension divider, 10 inches, Sargent's No. 51	.52	.52
3 socket mortise chisels, ¼ inch, Buck Bros.' No. 48	2.00	2.00
3 socket mortise chisels, ⅜ inch, Buck Bros.' No. 48	2.20	2.25
3 socket mortise chisels, ½ inch, Buck Bros.' No. 48	2.50	2.50
4 smoothing planes, Stanley's Bed Rock, No. 604, or Sargent's No. 9.....	6.50	6.75
1 joiner plane, Stanley's Bed Rock, No. 607...	2.80	2.85
2 block planes, Stanley's No. 140.....	.92	.94
1 double end block plane, Stanley's No. 130....	.47	.50
1 low angle block plane, Stanley's No. 65.....	.87	.95
1 plow plane, Stanley's No. 45.....	5.50	5.85
2 drawing knives, 6 inches, D. R. Barton's No. 85	1.80	1 80
1 drawing knife, 8 inches, D. R. Barton's No. 88	1.00	1.25
1 shingle hatchet, Sargent's No. 201..... Or Plumb's No. 591, 55c.	*.90	.90
1 cabinet scraper, Sargent's No. 25, 3x5 inches..	.20	.20
2 hand saws, 26 inches, 7 points, Disston's No. 8	2.66	2.69
2 rip saws, 26 inches, 6 points, Disston's No. 8D	2.75	3.04
1 rip saw, 28 inches, 5 points, Disston's No. 8D	1.52	1.59
2 nests of saws, Disston's No. 3.....	1.50	1.50
4 coping saws, Disston's No. 10.....	2.20	2.20
2 turning saws, 18 inches, Miller Falls.....	1.63	1.83
1 miter box and saw, Stanley's No. 240.....	7.65	7.90
1 saw set, Monarch, No. 2, medium.....	.75	.75

1 saw clamp with filing guide, Disston's No. 4..	1.05	1.05
2 ratchet braces, 8-inch sweep, Barber's No. 733A	3.00	3.00
Or Stanley's No. 921, $2.66.		
1 ratchet brace, 10-inch sweep, Barber's No. 732	1.60	1.60
Or Stanley's No. 921, $1.50.		
1 set auger bits, Nos. 4 to 16, R. Jennings....	4.50	5.50
8 gimlet bits, 2 each, 3/32, 4/32, 5/32, 6/32, Sargent's double cut	.54	.54
2 Rose counter sinks, Sargent's	.20	.34
1 screwdriver bit, D. R. Barton's or Buck Bros.'	.15	.20
1 expansion bit, Sargent's No. 81	*1.00	1.00
1 hollow auger, Cincinnati Tool Co., No. 3....	4.00	4.00
1 ¾-inch plug cutter, Cincinnati Tool Co.'s Improved	.26	.26
2 sets nail sets, Goodell's No. 900	1.68	1.70
4 copperized steel oilers, ½ pint	.40	.45
3 adze-eye claw hammers, 13 ounces, Maydole..	1.38	1.38
2 pairs steel bar adjustable clamps, 2½ feet, Cincinnati Tool Co.'s Special Perfection	*5.25	5.35
1 pair steel bar adjustable clamps, 5 feet, Cincinnati Tool Co.'s Special Perfection	*3.50	3.50
2 screwdrivers, 4 inches, Champion or Stanley's No. 20	.33	.36
1 screwdriver, 6 inches, Champion or Stanley's No. 20	.25	.25
1 screwdriver, 12 inches, Champion	.46	.50
1 monkey wrench, 8 inches, P. S. & W.	.42	.42
Or Sargent's No. 77, 30c.		
6 pairs steel spindle hand screws, 10 inches, Oliver's "Peerless"	*4.32	4.32
1 tool grinder, Pike Peerless Senior, No. 9....	5.25	5.25
Or Pike Greyhound, No. 15, $9.00.		
1 Stanley dowling gig, No. 59	1.30	1.35
1 electric glue heater, Oliver's R. J	*14.00	14.00
	$112.41	$116.99

Minimum Equipment for Concrete Work, for Class of 6.

4 laborers' shovels, Ames' No. 3	$ 3.80	$ 4.00
1 sand screen, ¼-inch or ⅜-inch mesh, 2x5½ feet, Hill & Griffith's No. 249	3.00	3.00
1 measuring box for mixture, 1 to 1½ to 3, 1½ by 2 feet by 10 inches, estimate	.50	.60
1 measuring box for mixture, 1 to 2 to 4, 2′-0″x2′-4″x10″, estimate	.60	.70
1 mixing platform, 10x10 feet, estimate	3.00	4.00
1 steel concrete wheelbarrow	3.00	4.50
1 water barrel	.75	1.25
2 galvanized iron 8-quart buckets	.32	.40
2 smooth-face floats, S. & H., No. 52	1.80	2.00
1 straight edge hoe	.50	.65
	$ 17.27	$ 21.10

Complete Equipment for Concrete Work, for Class of 6.

4 laborers' shovels, Ames' No. 3	$ 3.80	$ 4.00
1 sand screen, ¼-inch or ⅜-inch mesh, 2x5½ feet, Hill & Griffith's No. 249	3.00	3.00
1 foundry riddle, ¾-inch mesh, 18 inches diameter, Hill & Griffith's No. 55	.40	.45
1 foundry riddle, ½-inch mesh, 18 inches diameter, Hill & Griffith's No. 55	.40	.45
1 foundry riddle, 3/16-inch mesh, 16 inches diameter, Hill & Griffiths No. 54	.40	.45
1 measuring box for mixture, 1 to 1½ to 3, 1½ by 2 feet by 10 inches, estimate	.50	.60
1 measuring box for mixture, 1 to 2 to 4, 2x2 feet 4 inches by 10 inches	.60	.70
1 mixing platform, 10x10 feet, estimate	3.00	4.00
2 steel concrete wheelbarrows	6.00	9.00
1 water barrel	.75	1.25
2 galvanized iron 12-quart buckets	.32	.40
1 galvanized iron sprinkling can, 6 quarts	.35	.45
4 smooth-face floats, S. & H., No. 52	3.60	4.00
2 wood floats		

2 molder's finishing trowels, 1¾x6 inches, Hill & Griffith's No. 802	1.20	1.40
1 joiner, Stearns' No. 109	.35	.40
1 straight edge hoe	.50	.65
	$ 25.17	$ 31.20

Minimum Equipment for Forging and Sheet Metal Work, for Class of 6.

3 geared blower forges, Buffalo, No. 651. Or Champion, No. 73, $19 each.	$ 52.50	$ 54.00
3 100-pound anvils, Hay-Budden or Trenton	33.00	36.00
3 forge shovels	.20	.30
3 forge pokers	.20	.25
3 forge ladles, 4 inches	.75	1.20
3 hardies, 1½ inches	.60	.65
3 hot chisels, 1¼ inches	.95	1.05
3 ball pein hammers, 1¼ or 1½ pounds, Maydole	1.06	1.20
3 steel squares, Nicholl's No. 10	1.33	1.45
3 pairs plain calipers, 6 inches, Sargent's	.40	.50
3 ⅜-inch flat jaw tongs, 16 inches	.60	.75
3 ½-inch flat jaw tongs, 16 inches	.75	.90
3 ¾-inch flat jaw tongs, 16 inches	.90	1.00
3 ½-inch bolt tongs, 16 inches	1.05	1.10
1 cross pein sledge hammer, 5 pounds	.40	.45
2 flatters, 2 inches	.95	1.05
2 set hammers, 1¼ inches	.56	.60
2 handled cold chisels, 1¼ inches	.70	.75
2 handled punches, 1 each, ¾ inch, ½ inch	.40	.50
1 set each, top and bottom swages, ⅜ inch, ½ inch, ¾ inch	2.30	2.40
1 set each, top and bottom fullers, ⅜ inch, ½ inch, ¾ inch	2.20	2.40
1 post drill, Champion, No. 96	11.50	12.00
1 40-pound blacksmith vise, 3½-inch jaws	4.50	5.00
6 twist drills, ½ inch, straight shank; 2 each, ¼ inch, ⅜ inch, ½ inch	1.60	1.75
2 center punches	.20	.25

3 tinner's hand snips, P. S. & W., No. 6½	7.50	8.00
1 tinner's stake, P. S. & W., No. 4	8.50	9.00
2 riveting hammers, P. S. & W., No. 5	.70	.80
2 rivet sets and headers, No. 4, P. S. & W., 46	.50	.50
3 soldering sets, P. S. & W., No. 11	1.05	1.05
1 tinner's fire pot, cast iron, P. S. & W., No. 1	3.25	3.50
1 heavy work bench, estimate	5.00	10.00
	$146.05	$160.30

Complete Equipment for Forging and Sheet Metal Work, for Class of 6.

5 geared blower forges, Buffalo, No. 651	$ 87.50	$ 90.00
Or Champion, No. 405, $27.50 each.		
4 100-pound anvils, Hay-Budden or Trenton	44.00	48.00
1 150-pound anvil, Hay-Budden or Trenton	16.50	18.00
5 forge shovels	.35	.50
5 forge pokers	.35	.42
5 forge ladles	1.25	2.00
5 hardies, 1½ inches	1.05	1.12
5 hot chisels, 1¼ inches	1.54	1.65
5 ball pein hammers, 1¼ or 1½ pounds, Maydole	1.73	2.00
5 steel squares, Nichols' No. 10	2.20	2.40
5 pairs plain calipers, 6 inches, Sargent's	.67	.83
5 tight grip tongs, No. 1	*3.75	3.75
5 ¼-inch flat jaw tongs, 16 inches	1.00	1.25
5 ⅜-inch flat jaw tongs, 16 inches	1.25	1.50
5 ½-inch flat jaw tongs, 16 inches	1.25	1.50
5 ⅝-inch flat jaw tongs, 16 inches	1.50	1.65
3 ⅝-inch bolt tongs	1.75	1.85
5 ½-inch bolt tongs	1.75	1.85
5 leather aprons, split, A grade, 26x36 inches	6.25	6.25
2 cross pein sledge hammers, 5 pounds	.80	.90
3 flatters, 2 inches	1.47	1.65
3 set hammers, 1¼ inches	.84	.90
3 handled cold chisels, 1¼ inches	.90	.90
6 handled punches, 2 each, ¼ inch, ⅜ inch, ½ inch	2.40	3.00

2 sets each, top and bottom swages, $\frac{3}{8}$ inch, $\frac{1}{2}$ inch, $\frac{3}{4}$ inch	4.40	4.80
2 sets each, top and bottom fullers, $\frac{3}{8}$ inch, $\frac{1}{2}$ inch, $\frac{3}{4}$ inch	4.40	4.80
2 heading tools, $\frac{1}{2}$ inch	.70	.80
1 post drill, Champion, No. $4\frac{1}{2}$	16.00	16.50
1 40-pound blacksmith vise, $3\frac{1}{2}$-inch jaws	4.50	5.00
2 center punches	.20	.25
8 straight shank twist drills, 2 each of No. 13, 19/64 inch, 13/32 inch, $\frac{1}{2}$ inch	1.34	1.40
4 straight shank twist drills, 2 each of 3/16 inch, $\frac{1}{4}$ inch	.32	.35
1 tap wrench and set of taps and dies for $\frac{1}{4}$ inch, $\frac{3}{8}$ inch, $\frac{1}{2}$ inch, $\frac{5}{8}$ inch, net size, O. K., 5T	7.00	7.00
1 hack saw, Miller Falls Co.'s No. 6	.80	.80
4 tinner's hand snips, P. S. & W., No. $6\frac{1}{2}$	10.00	10.65
1 hawk's bill shears, P. S. & W., No. 15	3.00	3.00
1 tinner's stake, P. S. & W., Beakhorn, No. 4	8.50	9.00
1 candle mold stake, P. S. & W.	2.25	2.25
1 square stake (S. & C.), P. S. & W.	2.65	2.65
3 riveting hammers, P. S. & W., No. 5	1.05	1.20
2 set hammers, P. S. & W., No. 4	.50	.50
1 set hollow punches, one each, $\frac{1}{2}$ inch, $\frac{3}{4}$ inch, 1 inch	1.60	1.60
2 rivet sets and headers, No. 4, P. S. & W., No. 46	.50	.50
6 soldering sets, P. S. & W., No. 11	2.10	2.10
2 tinner's fire pots, cast iron, P. S. & W., No. 1	6.50	7.00
1 heavy work bench, 2 feet wide, 12 feet long	5.00	15.00
	$265.36	$291.02

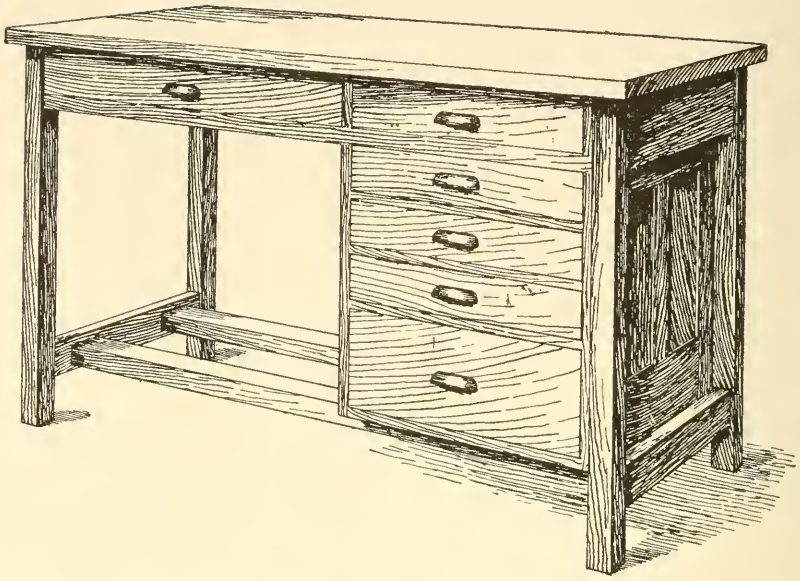
Minimum Equipment for Mechanical Drawing, for Class of 12.

12 drawing board frames, one for each work bench, estimate	$ 1.80	$ 3.00
12 drawing boards, $\frac{3}{4}$x16x24 inches	8.40	10.80
12 pear wood T squares, 24 inches, K. & E., No. 2300	*2.52	2.52

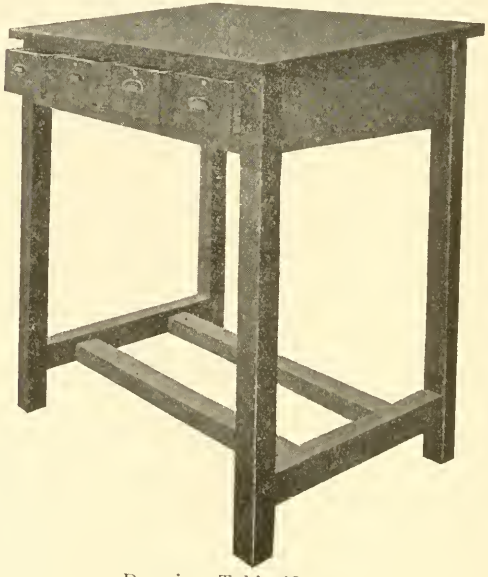
12 sets drawing instruments, Frederick Post Co.'s No. 1084	*$34.80	34.80
Or Keuffel & Esser Co.'s Excelsior, No. 9526F, at $2.65 each.		
12 transparent triangles, 45° 7″, K. & E., Xylonite, No. 8802, or Frederick Post Co.'s No. 1748	*2.48	2.48
12 transparent triangles, 30x60° 9″, K. & E., Xylonite, No. 8803, or Frederick Post Co.'s No. 1747B	*2.63	2.63
12 architect's triangular boxwood scales, No. 8881, 12 inches	*3.50	3.50
1 teacher's drawing table, Keuffel & Esser Co.'s No. 2599C	*11.90	11.90
	$ 68.03	$ 71.63

Complete Equipment for Mechanical Drawing, for Class of 12.

12 drawing tables, No. 4, page 24, estimate	$114.00	$114.00
Or Grand Rapids Hand Screw Co.'s No. 206, D. T., $15.54 each.		
12 pear wood T squares, K. & E., No. 2310	6.48	6.48
12 sets drawing instruments, Keuffel & Esser Co.'s Challenger, No. 9726F, with No. 802 and No. 804 pens	*52.80	52.80
Or Frederick Post Co.'s No. 1084, $2.90 each.		
12 transparent triangles, 45° 7″, K. & E., Xylonite, or Frederick Post Co.'s No. 1748B	*3.12	3.12
12 transparent triangles, 30x60° 9,″ K. & E., Xylonite, or Frederick Post Co.'s No. 1747B.	*3.12	3.12
12 architect's triangular boxwood scales, 12 inches, white edges, K. & E., 1621W	*14.40	14.40
4 transparent curves, K. & E., Xylonite, 1 each, 2, 13, 24, 27	*1.08	1.08
1 teacher's drawing table No. 3, page 24	20.00	20.00
	$245.00	$245.00



Teacher's Drawing Table No. 3.



Drawing Table No. 4.

The combined cost of the equipments listed and recommended for woodwork, concrete work, forging, sheet metal work, and mechanical drawing, will be from $487.45 to $515.37 for the minimum equipment, and from $951.58 to $1002.66 for the maximum.

When power is available, either a band-saw or a saw-table should be included in the general equipment. Either of these machines will enable the teacher and pupils to accomplish much more in the time set aside for the shopwork, for without this means of getting out stock too much time must be devoted to the rougher work. The following machines are recommended: Oliver Variety saw table, No. 32A, $120; Oliver band saw, No. 17, 30 inch, $120; Fay and Egan band saw, No. 155, $110, and No. 330 C Variety saw, $110. For lower priced tools the following are suggested: Crescent saw table, No. 2, $93.75; Crescent band saw, 32 inch, $78.75.

The power required to drive either of the saw tables or either band saw will not exceed three horse power where no line shafting is used. The line shafting pulleys and belting will vary with the kind and location of the motor, but the cost will rarely exceed $25.

Any of the following motors and gasoline engines will be found satisfactory: Westinghouse or General Electric Co.'s alternating current induction three phase motors; Wagoner Electric Co.'s or Century Co.'s alternating current induction single phase motors; Westinghouse or General Electric Co.'s direct current shunt wound 110 or 550 volt motors; Stover Engine Work's horizontal gasoline engines.

The following prices of motors and engines will serve as guides in completing the estimate for the complete equipment:

Alternating Induction Motors, Complete.

H.P.	Volts.	Cycle.	Phase.	Speed.	Price.
2	110	60	3	1700 to 1800	$ 55.00
3	110	60	3	1200	71.00
3	110	60	3	1700 to 1800	62.00
3	110	60	3	1200	82.00
5	110	60	3	1700 to 1800	72.00

Alternating Induction Single Phase Motors.

H.P.	Volts.	Cycle.	Speed.	Price.
2	110 or 220	60	1750	$ 90.00
3	110 or 220	60	1750	110.00
5	110 or 220	60	1750	136.00
5	110 or 220	60	1165	171.00
5	110 or 220	60	870	208.00

Direct Current Shunt Wound Motors, Complete with Slide Rails, Rheostat and Pulley.

H.P.	Volts.	Speed.	Price.
2	110	1200	$ 92.00
2	110	1700	69.00
3	550	1350	98.00
2	550	2000	73.00
3	110	1150	113.00
3	110	1650	95.00
3	550	1800	98.00
3	550	1200	120.00
5	110	1800	113.00
5	110	1100	140.00
5	550	1800	125.00
5	550	1200	150.00
5	550	2000	121.00
5	550	1350	145.00

Prices of Gasoline Engines—Stover Horizontal Engines, 4-Cycle, with Water Tank and Muffler.

4 H. P.	$140.00
6 H. P.	250.00
8 H. P.	300.00

EQUIPMENT FOR COURSES IN GROUP II.

The specifications of tools when not given may be found in the list of equipment for Group I.

Minimum Equipment for Bench Woodwork—Individual Tools for Class of 16.

16 try-squares, No. 20	$ 2.15	$ 3.05
16 two-foot rules, No. 1	2.30	2.66
16 marking gauges, No. 77	3.98	4.00
16 jackplanes, No. 5C, or V. B. M., 14	26.40	30.19
16 tanged firmer chisels, $\frac{1}{4}$ inch, No. 30	5.85	5.85
16 tanged firmer chisels, $\frac{1}{2}$ inch, No. 30	6.40	6.67
16 tanged firmer chisels, 1 inch, No. 30	7.53	8.33
16 cabinet saws, Disston's No. 80, 14 inches	10.00	10.35
16 Maple bench hooks	4.00	4.00
16 bench dusting brushes, No. 502, 8 inches	3.34	3.34
16 single work benches, No. 1, with Wilcox rapid acting vise, 2308, No. 1, and Cincinnati Tool Co.'s bench stop	192.00	192.00
	$263.95	$270.42

General Equipment.

General equipment listed for Group I	$ 62.79	$ 64.70
6 spoke shaves, No. 54	2.35	2.35
4 metal T bevels, No. 18	1.29	1.33
3 extension dividers, No. 51	1.17	1.17
1 hand saw, 26 inches, 7 points, No. 8	1.33	1.35
2 coping saws, No. 40	1.10	1.10
1 ratchet brace, 8-inch sweep, Barber's No. 733	1.35	1.35
3 each of auger bits, $\frac{1}{4}$ inch, $\frac{3}{8}$ inch, $\frac{1}{2}$ inch	2.16	3.38
8 adze-eye, bell-face claw hammers, Stanley or Maydole, 10 ounces	3.20	3.60
2 pairs steel bar clamps, 3 feet	5.60	5.60
4 pairs steel spindle hand screws, 10 inches	2.88	2.88
	$ 85.22	$ 88.81

Complete Equipment for Bench Woodwork, for Class of 16.

INDIVIDUAL TOOLS.

16 each of tools listed in individual equipment for class of 12, Group I	$404.85	$424.60
16 block planes, Stanley's 9½, or Sargent's V. B. M., 5306	11.20	12.00
16 Champion screwdrivers, 6 inches	4.00	4.00
16 metal T bevels, No. 18	4.00	4.00
	$424.05	$444.60

General Equipment.

General equipment listed for Group I	$112.41	$116.99
3 extension dividers, 6 inches	1.17	1.17
3 socket mortise chisels, ⅜ inch, No. 48	2.25	2.25
3 socket mortise chisels, ½ inch, No. 48	2.50	2.50
1 joiner plane, No. 607	2.80	2.85
5 cabinet scrapers, 3x5 inches	1.00	1.00
4 hand saws, 26 inch, 7 point, Disston's No. 8	5.32	5.38
2 rip saws, 26 inch, 6 points, Disston's No. 8D	2.75	3.04
4 each ½-inch, ¾-inch, 1-inch socket firmer gouges, Buck Bros	7.00	7.80
2 ratchet braces, 8-inch sweep, Barber's No. 733A	3.00	3.00
1 set auger bits, Nos. 4 to 16	4.50	5.50
2 screwdriver bits	.30	.40
4 pairs steel bar clamps, 2½ feet	9.80	9.80
4 pairs steel spindle hand screws, 10 inches, Oliver's Peerless	*2.88	2.88
8 carving sets, S. J. Addis' No. 13	*21.60	21.60
1 wood trimmer, Oliver's 1A	*35.00	35.00
1 hand joiner, 6 inches round head, Oliver's 144B, with guard	85.00	85.00
1 wall tool case, estimated	40.00	40.00
	$339.28	$347.16

Minimum Equipment for Wood Turning, for Class of 8.

8 Wells' manual training lathes, 12 inches by 4 feet, on long legs and with Idler under drive.	*$460.80	$460.80
1 motor, 5 H. P., direct current. Or 5 H. P. induction motor, $72.	113.00	150.00
8 sets wood turner's tools, consist of 1 each, 1-inch straight gouge, ¾-inch turner's gouge, 1-inch turner's gouge, 1-inch turner's skew chisel, ½-inch turner's skew chisel, ⅝-inch round nosed chisel, ¾-inch cutting off chisel, Buck Bros.' or D. R. Barton's	29.00	32.00
8 steel oilers, P. W. Mfg. Co.'s No. 304, ½ pint	.80	.90
8 pairs 6-inch outside calipers, Starrett's No. 26	3.20	4.00
8 pairs 6-inch inside calipers, Starrett's No. 27	3.20	4.00
8 hickory mallets, 3x5 inches	.92	1.17
8 two-foot rules, Stanley's No. 1	1.16	1.34
8 bench dusting brushes, Bromwell's No. 502, 8 inches	1.67	1.67
	$611.05	$655.88

Complete Equipment for Wood Turning.

8 motor drive turning lathes with A. C. motors, 12-inch swing, 36 inches between centers, F. E. Wells & Son Co.'s. Or F. E. Reed Co.'s New Model, $140 each, or Oliver Co.'s No. 55, $138 each.	*$891.20	$891.20
8 sets turner's tools, consisting of 1 each, 1-inch straight gouge, 1¼-inch skew chisel, 1-inch skew chisel, ⅝-inch skew chisel, ¼-inch skew chisel, 1¼-inch turner's gouge, 1-inch turner's gouge, ⅝-inch turner's gouge, ½-inch cutting off chisel, ⅝-inch round nosed chisel, Buck Bros.' or D. R. Barton Co.'s	45.00	50.00
8 pairs 6-inch outside calipers, Starrett's No. 26	3.20	4.00
8 pairs 6-inch inside calipers, Starrett's No. 27	3.20	4.00
8 hickory mallets, 3x5 inches	.92	1.17
8 two-foot rules, Stanley's No. 1	1.16	1.34

8 bench dusting brushes, Bromwell's No. 502. 8 inches	1.67	1.67
8 steel oilers, P. W. Mfg. Co.'s No. 304, ½ pint	.80	.90
	$946.65	$954.28

Minimum Equipment for Sheet Metal, Forging, and Machine Shopwork for a Class of 12.

Equipment listed for "Sheet Metal and Forging, Group I"	$265.36	$291.02
6 sets, individual tools, Starrett's No. 900 or No. 901	27.00	27.90
1 swivel vise, 4-inch or 4½-inch jaws, Athol Machine Co.'s No. 710, or Reed Mfg. Co.'s No. 204½	7.50	8.00
2 stationary base vises, 3½-inch jaw, Athol Machine Co.'s No. 711	10.68	10.68
Or Reed Mfg. Co.'s No. 103½, $4.50 each.		
3 ball pein hammers, 1¼ pounds, Maydole or Stanley	1.06	1.20
1 Starrett's No. 202 micrometer	4.13	4.50
1 Starrett's No. 4, screw pitch gauge	.94	1.00
1 Starrett's No. 155, screw pitch gauge	1.13	1.25
1 Starrett's No. 52, surface gauge	1.50	1.75
1 Starrett's No. 106 speed indicator	1.13	1.25
Material for work bench to be made by pupils	10.00	15.00
1 engine lathe, 12 inches by 5 feet, with compound rest and spindle, with Morse taper, Reed Prentice Co.'s	*290.00	290.00
Or Champion Co.'s.		
1 drill press, Rockford, 14 inches, power feed, fitted with No. 2 Morse taper sleeve	*57.00	57.00
1 crank shaper, 16 inches, Stockbridge, single geared	*325.00	325.00
Or Rockford, 14 inches.		
1 Detroit, No. 3, emery grinder	37.25	38.25
1 power hack saw, Miller Falls, No. 89	18.44	19.50
1 breast drill and chain chuck, Miller Falls, No. 25	2.60	3.00

1 5-H. P. A. C. motor, 3 phase or single phase	*72.00	136.00
Pulleys, belting, etc.	50.00	75.00
1 Westcott's 10⅜-inch independent lathe chuck, with four jaws, with face plate casting	*14.80	14.80
1 Westcott's 8-inch geared combination lathe chuck, three jaws, with face plate casting	16.10	16.10
1 Little Giant drill chuck, No. 1, fitted to lathe spindle	6.65	6.65
1 set of Armstrong lathe tools, consisting of 1 each, straight shank No. 18, boring tool, No. 9, with bushing and ½-inch bar. Drill holder No. 2. Cut-off, No. 31R. Right hand side tool, No. 71R	8.60	8.60
1 Armstrong planer tool, No. 401	*2.45	2.45

In addition to the above equipment, a large number of small special tools will be needed, but these should be selected by the teacher with special reference to the exercises and projects planned. These small tools will cost from $25 to $50, making the total for the complete equipment from $1256.32 to $1405.50.

Minimum Equipment for Mechanical Drawing, for Class of 16.

16 drawing board frames	$ 2.40	$ 4.00
16 drawing boards	11.20	14.40
1 teacher's drawing table	11.90	11.90
	$ 25.50	$ 30.30

Complete Equipment for Mechanical Drawing for Class of 16.

16 drawing tables, No. 4	$192.00	$192.00
48 drawing boards	33.60	43.20
1 teacher's drawing table	20.00	20.00
1 cabinet for material and for students' drawings	15.00	15.00
	$260.60	$282.20

Pupils should furnish their own drawing instruments.

The combined cost of the equipment recommended for woodwork, turning, sheet metal, forging, machine shopwork, and mechanical drawing for schools in Group II will be from $2241 to

$2450.90 for the minimum and from $3186.90 to $3433.75 for the maximum.

EQUIPMENT FOR THE MODERN MANUAL TRAINING HIGH SCHOOL.

The selection of a complete equipment for the large city high school and the perfecting of plans for the proper installment of this equipment constitute a complicated engineering problem. This problem can be successfully solved only by an expert who is familiar with every factor that might affect the manual training department. The plan of the building, details of construction of the building, general organization of the school, course of study, and the size and schedule of proposed classes must be considered minutely.

As almost all of the large city high schools have fairly good equipment for shopwork and mechanical drawing, or have competent supervisors who can plan all changes and additions needed, no special list of equipment for these schools is given in this bulletin. The list of equipment given for "Group II" should be sufficient to guide any school just starting a manual training department. However, the University, through its visitor of schools, is ready at all times to assist any school dealing with this problem.

LOCATION AND PLAN OF SHOPS.

The efficiency of the manual training department of any school depends to a great extent upon the location of the laboratories in relation to other departments. If the shop is located so as to cause the noise incident to hand-tool and machine operations to disturb classes engaged in recitations, trouble is sure to arise, and some of the operations will have to be postponed until after school.

The shape, size and character of the room are very important factors in the success or failure of the work. Poor arrangement of equipment, poor light, poor ventilation, and lack of working space for each pupil are the causes of the bad results found in many schools.

Where rooms in an old building must be used it is often very difficult to select the ones best suited to the needs of the manual

training work. A consideration of the following requirements, however, will aid in the proper selection of rooms and in planning a satisfactory installation of the equipment.

Location.—Machinery should be installed on the ground floor. This is necessary, generally, in order to have firm foundations for machines. If overhanging shafting is to be used and the building is of frame construction the shop should not be under a classroom. The vibration would be intolerable in the classroom. Partitions and floors between shops and classrooms should be thoroughly deadened to prevent the transmission of sound. Washrooms should be near the shops, otherwise each shop should be provided with one or more wash basins conveniently located within the shop. The drawing room should be located near the woodworking shop, but need not be on the same floor.

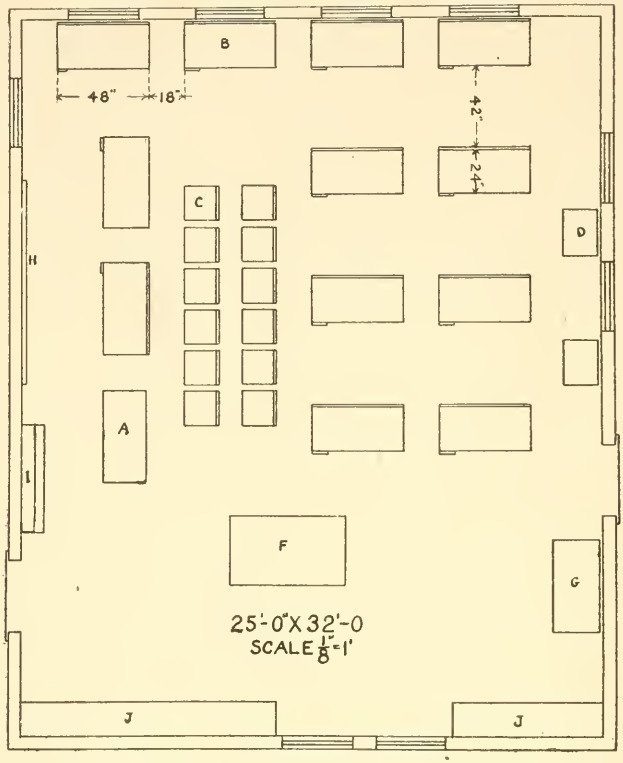
Lighting.—Abundant light is very essential for shopwork and for mechanical drawing. Exact mechanical work, such as sawing or cutting to knife lines, if attempted under any but the best lighting conditions, is sure to result in poor work and badly strained eyes. It would be far better to use a poorly lighted room for Latin, or geometry classes than for pupils trying any form of fine mechanical operations. The light should come from in front of, and to the left, of the worker. If artificial light must be used, a drop light should be placed above the back left hand corner of each bench, as well as over every other station occupied by the workers. Windows should extend up close to the ceiling. North light is especially desirable for the class in mechanical drawing.

Ventilation.—The shops should be well ventilated, as an abundance of fresh air is necessary to pupils engaged in vigorous exercise of mind and body. The working positions bring the pupils in close contact with much finely divided dust, coming from the material worked upon. It is important to eliminate this dust as quickly as possible by a good circulation of fresh air.

The shop should have good heating facilities, so that the temperature can be controlled without interfering with the proper ventilation. Moist warm air should not be admitted into a cold room where tools and machinery are kept, as the cold metal will become covered with moisture, which will cause the rusting of the iron and steel parts.

Basements with floors that are more than two feet below the

surface of the school ground should not be used for shops, as such rooms often become cooler than the outside atmosphere.



The above plan shows a satisfactory arrangement of equipment for bench woodwork and mechanical drawing. The plan contemplates the use of twelve (B) No. 1 or No. 2 single benches, provided with drawing board frames to fit top of the benches; twelve (C) tablet arm chairs, one (A) teacher's drawing table, two (D) drawing board cabinets, one (F) saw table or band saw, one (I) tool case, one (G) glue and paint table, and two (J) lumber racks.

Floors.—All shops except the forge shop and the foundry should have wooden floors. Such floors are far more comfortable than are concrete or brick floors, and cause less damage to tools that may fall upon the floor.

Space.—The amount and the shape of the floor space required for each laboratory and auxiliary room will depend upon the size of the class, the type of equipment, and the kind of work to be done.

Eighteen by twenty-six feet, 22x22 feet, or 16x30 feet are dimensions of rooms suitable for shops for bench woodwork and mechanical drawing for a class of twelve pupils. These small rooms would not afford sufficient demonstration space, or space for machinery; 26x32 or 25x34 feet are dimensions of rooms suitable for bench woodwork and mechanical drawing, and provide space for demonstration and for a hand saw or a table saw.

A room 24x38 feet, with windows on two sides and on one end, would afford excellent space and good arrangement for a class of twelve pupils in bench woodwork, mechanical drawing, carpentry, furniture making, and concrete work. It would also provide ample space for demonstrations and for a hand saw or table saw; 20x25 or 15x36 feet are dimensions suitable for a drawing room to accommodate a class of twelve.

A study of the lay-out shown in the plan on page 34 will give other detailed information, such as the spacing of equipment, needed in planning a shop for any size class.

DETAILED OUTLINES OF SHOPWORK.

The problems and the arrangement of the work given in the following outlines are merely suggestive. They may be altered by the teacher to meet local conditions and individual needs. The purpose has been to outline courses containing the fundamental elements and processes essential to every good course in shopwork. These courses are sufficiently organized to enable the trained teacher to secure definite, desirable results. The instruction and execution of the work should awaken and hold the interest of the pupil and cause him to acquire the following:

(a) Skill in the correct practical use of tools and machines.

(b) Knowledge of materials used; of tools and machines, their design, development, and use in the industries; of mechanical processes, principal operations, arrangement of operations, time required; of principles of decorative and structural design.

(c) Ability to read and make working drawings.

(d) Power of mechanical analysis.

(e) Increase in initiative and inventive ability.

(f) Habits of neatness, accuracy, and industry.

(g) Right appreciation of labor and of the works of industrial art.

GROUP SYSTEM.

The arrangement of the course with a number of similar problems in each group, enables the teacher to give class instruction planned for in advance of the current lesson. This makes it possible to give better prepared demonstrations, and avoids the needless repetition so common to other systems. The apt pupil will complete two or more problems of the group while the slow pupil may complete but one before the next class of work or group is taken up by the class. Of course, any problem not finished when the new group is taken up should be completed by the pupil before he starts a problem in the new group. It is important, however, that the instruction be applied, to some extent, soon after it is given; and the teacher should see that each pupil not ready to start a new model completes a small exercise before again proceeding with the old model. By the careful use of exercises and selection of problems, the class can be kept close together.

SUBJECT-MATTER AND RELATED INFORMATION.

In the outlines of shopwork the study of tools, processes, and principles of construction is clearly indicated. The pupil is concerned with this subject-matter at once. He recognizes it as a means to his immediate end of making some model. There is much other useful knowledge closely related to or suggested by the problems undertaken by the pupil. Although not necessary to the immediate success of the work, this related matter is important educationally and can be woven into the course by a proper treatment of the problems and lessons.

SUPPLEMENTAL WORK.

As the amount of work that can be done by the pupil during the regular shop period is very small, the models must, as a rule, be small or few in number. It is doubtful if more than two double periods of the regular school day can be justly devoted to manual training each day; but as the pupils are generally anxious for more time in the shop, the school should

provide for the use of the shop after school hours and on a part of Saturday, thus enabling the pupils to undertake larger projects. Such shopwork and drawing done after school or any handtool work done at home, if done entirely by the pupil and under the direction of the teacher, should give the pupil credit towards high school graduation. The granting of one or one-half unit of credit towards graduation would, no doubt, encourage a kind of after school work of great educational and practical value. The design, the working drawing, and the plan of work, should be approved by the teacher if the work is to be presented for credit.

As a rule, the model or work undertaken, should fit in with the group of work, in the outline, which the pupil is dealing with in the regular shop period, or else should fit in with one of the groups just below. In case the project as a whole does not fit in with the group, then any parts of the project that may fit in with the group could be selected as the basis of credit.

The pupil should be required to keep an accurate record of the time devoted to the model or work, and should report the progress of the work from time to time. An inspection of the work should be provided for, and great care should be exercised in establishing the worth of any piece of work. In doing this, not only the finished project, but the tools used and all conditions affecting the pupil's efforts, should be considered.

WOODWORK.

(A) Bench Work. (See note at bottom of this page.)

(1) Laying out with rule, pencil and try-square; cross-cut sawing; fastening with nails.

New Tools—Rule, try-square, cross-cut saw, hammer.

Problems—Flower pot bench, dry plate rack, seed germinating box, test exercise.

(2) Surfacing with plane, gauging, rip sawing.

New Tools—Smoothing plane or jack plane, marking gauge, rip saw.

Problems—Flower trellis, cover for poultry drinking or feed trough.

(3) Squaring up stock, sawing to knife lines, chamfering with plane and chisel, boring, sand papering.

New Tools—Knife, back saw, chisel, brace and bit, sand paper.

Problems—Hat rack, rule, octagonal paper file, table mat, specimens of wood.

(4) Paring with chisel—chiseling out dado, vertical cutting, cutting round corners, planing end of stock with block plane, fastening with screws.

New Tools—Block plane, countersink, screwdriver.

Problems—Tool rack, bench hook, magazine rack.

(5) Sawing and modeling simple curved outlines.

New Tools—Coping saw, turning saw, spoke shave, file.

Problems—Oval table mat, bread board, coat hanger.

NOTE.—Where woodwork is taught in the grammar grades, the high school work should be started with the work outlined under Advanced Bench Work, and should include more of the advanced work.

(6) Modeling simple curved forms.

New Tools—Drawing knife.

Problems—Hatchet handle, hammer handle, spoke shave or scraper stock, canoe paddle.

(7) Gouging, line carving, tinted designs.

New Tools—Outside ground gouges, scrapers, veining tools.

Problems—Pen tray, desk tray, bread tray, book rack.

(8) Low relief carving.

New Tools—Carvers' gouges and chisels, background tools.

Problems—Blotter holder, paper file, ends of book rack.

(9) Rabbeting with rabbet plane, laying out for accuracy by superposition, half lap joint.

New Tools—Rabbet plane, cabinet scraper.

Problems—Exercise, picture frame, mirror frame.

(B) Advanced Bench Work.

(1) Box construction with accurately fitted butt, rabbet, and dado joints; fastening with brads and glue.

New Tools—Nail set, hand screws.

Problems—Stationery box, card catalogue case, half peck and peck measure, egg tester, knife and fork box.

(2) Mortise and tenon joints—slip mortise and tenon, through mortise and tenon, blind mortise and tenon, and keyed mortise and tenon.

New Tools—Mortise gauge, mortise chisel.

Problems—Exercises.

(3) Glued joints—butt, splined, and doweled.

New Tools—Plow, winding sticks.

Problems—Level stock, T square.

(4) Miter joints—butt and splined.

New tools—Miter box, frame clamp.

Problems—Exercise required. Picture or mirror frame, glove box, clock case, tray.

(5) Dove-tail joints—single halving, through multiple, and lap multiple, veneering, inlaying, hinge setting.

New Tools—Fret saw and frame, veneer press or clamps.

Problems—Exercises, glove box, jewel box, tea caddie, tea tray.

(C) Furniture and Cabinet Construction.

(1) Review of principles and processes given in (A).

Problems—Taboret with glued up top, mortise and tenon construction; combination footstool and shoe polish box, magazine stand.

(2) Board construction, art metal trimmings.

New Tools—Power jointer, saw table.

Problems—Music cabinet, cedar chest, settee with hinged top.

(3) Framed structures, fume and wax finish.

New Tools—Band saw.

Problems—Dining chair, Morris chair, arm rocker.

(4) Panel structures, drawer and drawer mechanism.

Problems—Small cabinet, desk.

(D) Carpentry.

(1) Forms for concrete work. (See Concrete Construction.)

Problems—Fence post, pier, foundation wall, feed or drinking trough, stile block, pedestal, flower box, garden seat.

(2) Elements of frame buildings.

(a) Framing.

Problems—Model of corner of house embracing sills, joists, bridging, corner post, studs and openings; model of corner embracing standard methods of enclosing and flooring; model of hip roof embracing sheathing and shingles.

(b) Inside trim.

Problems—Model corner of room embracing flooring, base, window, door, and wainscot.

(E) Stair Construction.

Problems—Model of plain straight stair embracing newel, hand rail and balusters.

SUGGESTIVE TREATMENT OF PROBLEMS.

PROBLEMS.	DRAWING AND DESIGN.	MATERIAL.	TOPICS FOR CLASS DISCUSSION OR FOR HOME WORK.
(A) Benchwork:			
(1)	Full size working drawing on blackboard given to work from. Drawing to be compared with model. Other structural designs to be sketched in note-book.	Cypress or yellow pine, No. 1 common s2s ripped to required widths. Several boards of No. 1 common and of clear lumber for inspection. Wire brads and nails.	Geographical distribution of cypress and pine forests. Logging, Sawing, Grading of lumber. Board measure.
(2)	Working drawings, scale $\frac{1}{4}''$ or $\frac{1}{2}''=1''$, given to work from. Some dimensions to be found by use of scale. Design selected from several given.	Clear cypress s1s. Stock cut to size, allowing for ripping to be done by pupil. Stock bill to be made out by pupil.	Review of (1). Stock bills. Cost of lumber. Kind and sizes of nails. Manufacture of nails.
(3)	Free hand sketches and working drawings made by pupils from models. Drawings to be in note-books.	Clear red gum or yellow poplar (rough stock). Beeswax, turpentine. Specimens of poplar, cypress and yellow pine for study of grain, cross section, hardness, etc. Observations to be recorded in note-book.	Geographical distribution of forests continued. Difference between hard woods and soft woods. Pure and mixed forests. Wood structure. Beeswax and turpentine.

SUGGESTIVE TREATMENT OF PROBLEMS—continued.

PROBLEMS	DRAWING AND DESIGN.	MATERIAL.	TOPICS FOR CLASS DISCUSSION OR FOR HOME WORK.
(4)	Working drawings, scale $\frac{3}{8}''=1''$, and full size details given to work from. Isometric drawings of other designs, given to show relation of design to function and construction.	Clear red or white oak. s2s. Drawings, in note-book, of cross section and tangential section of specimens of (3) and of oak. Part of each section stained, and absorbing quality of each part recorded.	Kinds of oak. Plain and quarter sawn lumber. Method of sawing. Wood Structure. Method of seasoning. Meaning of design—structural and decorative. Kind and size of screws.
(5)	Working drawings, scale $\frac{3}{8}''$ or $\frac{1}{4}''=1''$, made by pupil from blackboard sketches giving principal dimensions. Design of edge to be made by pupil. Original design submitted by pupil to be used instead of design given when two models in group are made.	White pine, gum, or poplar s2s Bleached shellac, grain alcohol. Sand paper.	Composition of wood. Growth and life of the forest tree. Forest fires. Destructive lumbering. Woods suitable for buildings, furniture, woodenware, etc. Purpose of wood finishes. Shellac, alcohol, sand paper. Principles of design.
(6)	Working drawings, full size given to work from. Working drawings made by pupil from model, for use in case two models in group are made.	Straight grain hickory or ash. Specimens for study of strength, hardness, bending quality, etc., of hickory, ash, oak and pine. Boiled linseed oil.	Woods suitable for wagon stock, handles, implements, etc. Seasoning of hard woods. Design—size and form governed by use as shown by many types of handles.

(7) and (8)	Designs developed and working drawings made by pupil from blue prints giving details of construction, limiting dimensions, suggestive outlines and decorative designs. Decorative design rendered in color.	Yellow poplar or magnolia s2s. Water stains for tinted designs.	Kinds of carving. Historic examples of carving. Decorative design. Machine carving. Embossing of wood.
(9)	Working drawings made at home on note-book page. Limiting dimensions of moulding and of frame given on blue print. Color of wood or stain selected to suit picture and interior trim.	Any suitable wood used in previous models. Spirit stain, filler, wax.	Picture frames—design, construction. Design of mouldings. Relation of frame to pictures. Wood fillers.
(B) Advanced Benchwork.			
(1)	Design and working drawing made by pupil from statement of requirements and limiting dimensions.	1″ poplar or gum, s2s, to be resawn with rip saw. Good quality hide glue. Stain, shellac.	Re-sawing of lumber. Veneers. Kinds and quality of glue. Manufacture of glue. Flint and garnet paper, steel wool.
(2)	Free hand perspective sketches, by pupil, from working drawings of joints. Sketches to be in note-book.	Poplar or oak 2x2 rough stock. Stain, shellac varnish.	Choice of joints in construction. Structural design using joints as points of interest. Decorative treatment of joints. Varnish. Varnish finish. Rubbed finish. Machine-made joints.

SUGGESTIVE TREATMENT OF PROBLEMS—continued.

PROBLEMS.	DRAWING AND DESIGN.	MATERIAL.	TOPICS FOR CLASS DISCUSSION OR FOR HOME WORK.
(3)	Working drawings furnished to work from.	White pine, maple, birch, mahogany.	Mahogany forests. Substitutes for mahogany. Imitations of mahogany found in furniture. Manufacturing method of making glued joints, built up stock as cores for doors.
(4)	Working drawings to be made from perspective sketches and principal dimensions.	Oak or mahogany stain, filler, varnish, pumice stone.	Varnishes and varnish material. Rubbed and polished finish as used on pianos and other fine woodwork. Interior decoration.
(5)	Working drawing and decorative design in color made by pupil.	½″ red gum s2s. Birch, walnut, maple and mahogany veneer. Material for French polish.	Manufacturing of rotary cut veneers. Veneer panels. Bending of wood after steaming. Decorative design.
(C) Furniture and Cabinet Construction.			
(1)	Working drawings with full size structural details given. Outlines of top, legs, etc., and decorative design to be developed or altered by pupil.	Cypress or oak. Stain and wax.	Joints and other details used in furniture construction. Interior decoration. Manufacture of furniture.

(2), (3), (4)	Original designs and working drawings by pupils. Requirements of model, structural details, and limiting dimensions developed by class.	Any suitable wood selected by pupil.	Furniture design and construction. Art metal work. Interior decoration.
(D) Carpentry. (1)	Working drawings of models and of forms furnished to work from.	Yellow pine. No. 2, common, rough. No. 1, common, s2s.	Concrete. Requirements of wood forms for concrete casting. Concrete construction. Concrete work in progress in city or in neighborhood of school.
(2)	Floor plans, elevations and detail working drawings given to work from.	Yellow pine and cypress—No. 1 common, rough, s1s and s2s, and clear, s2s.	Architecture. Building trades.
(E) Stair Building.	Same as for (D), (2).	Same as for (D), (2).	Same as for (D), (2).

CONCRETE CONSTRUCTION.

(1) Crushing, sifting and washing material.
Tools Used—Heavy hammer, shovels, screens, trough.
Problem—Selection and preparation of aggregates.

(2) Mixing and placing concrete.
New Tools—Measuring boxes, sprinkler, mixing platform, tamper, spade.
Problems—Foundation block, fence posts, drain tile.

(3) Finishing with wooden float and trowel.
New Tools—Straight-edge or templet, float, trowel.
Problems—Square or hexagonal tile, section of walk, stile block, chimney cap.

(4) Casting hollow forms in wooden molds. Reinforcing.
Problems—Flower boxes, drinking and feed troughs, building blocks.

(5) Plaster molds for simple straight line and curved forms.
Problems—Flower boxes, vases.

SUGGESTIVE TREATMENT OF PROBLEMS.

PROBLEMS.	DRAWING AND DESIGN.	MATERIAL.	TOPICS FOR CLASS DISCUSSION OR FOR HOME WORK.
(1) and (2)		Sand, gravel, stone, cement, water.	Concrete structures. Other uses of concrete. Source, composition and quality of river sand, bank sand, stone used, cement, and other aggregates. Manufacture of cement. Strength of concrete.
(3)	Working drawings given to work from.	Same as for (1).	Concrete roads. Surface finish of concrete work. Wearing quality of concrete. Manufacture of cement.
(4)and (5)	Working drawings to be made from perspective drawings and principal dimensions.	Same as for (2), and plaster of Paris, No. 20 wire, and wire cloth. Expanded metal lath.	Decorative treatment of concrete, coloring. Water proofing. Reinforcing. Cost of concrete.

WOOD TURNING.

Experiments recently made in several high schools show that the traditional wood turning course, while logically and well planned as to subject-matter, violates some of the principles of good teaching. The two principles, that work should proceed from the simple to the complex, and should proceed from the easy to the more difficult, are the principles violated. The experiments show that much of the face-plate work is less difficult than any of the spindle work, and the processes involved are simpler. The following course, therefore, places the simple face-plate work first. This arrangement has the added advantages of permitting some useful models to be made early in the course, and of not requiring the exercises that demand great skill until after the pupil has become familiar with the principle of the turning lathe and with the tools to be used.

(A) Simple Face-plate Turning.

(1) Producing cylindrical and plane surfaces, V grooves; use of center screw.

New Tools—Large skew chisel, round nose chisel, outside calipers.

Problems—Exercise, coffee pot or flower pot stand, candlestick base.

(2) Turning low forms having profiles with curved outlines; use of face-plate screws; polishing with boiled oil or with wax.

New Tools—Inside calipers, templets.

Problems—Exercises, desk trays.

(B) Spindle Turning.

(1) Turning plain cylinders—single and in combinations.

New Tools—Plain gouge, turner's gouge, cut-off tool.

Problems—Exercise, towel roller, beam for marking gauge.

(2) Turning tapers and V grooves.

Problems—Exercise, molder's gate pins, dibble, mandrels.

(3) Convex and bead cuts.
Problems—Exercises.
(4) Concave cuts.
Problems—Exercises.
(5) Concave and convex cuts with gouge, polishing.
Problems—Exercises, chisel handles, candlesticks, Indian clubs, drawing forms, gavel heads.

(C) Advanced Face-plate Work.
(1) Use of cup chuck.
New Tools—Inside calipers.
Problems—Picture frame, towel ring, paper weight.
(2) Boring, finishing on mandrel between centers or on pin chuck.
Problems—Napkin rings, rope pulley.
(3) Turning boxes and covers.
Problems—Jewel box, collar box.

SUGGESTIVE TREATMENT OF PROBLEMS.

An even grained soft or hard wood may be used for the exercises. Some suitable hardwood or built up stock should be used for the other problems. All exercises suggested for spindle turning should be required.

PROBLEMS.	DRAWING AND DESIGN.	RELATED TOPICS FOR CLASS DISCUSSION OR FOR HOME WORK.
(1) and (2)	Full size working drawings given to work from. Note-book sketches of similar models applying principles of design to turned forms.	History and development of the turning lathe. How to figure speeds and sizes of pulleys. Lacing belts.
(b) (1), (2), (3) and (4)	Working drawings made by pupil from models. Collection by class of illustrations of forms of revolution showing good design.	The use of wood turning in pattern making, furniture making, and in mill work.

PROBLEMS.	DRAWING AND DESIGN.	RELATED TOPICS FOR CLASS DISCUSSION OR FOR HOME WORK.
(5)	Original designs and working drawings made by pupil from statement of requirements.	Different designs of turning lathes. Lathes for special purposes, as for turning handles, gun stocks, etc.
(c) (1) and (2)	Working drawings given to work from.	Different methods of driving lathes. Variety lathe. Use of waste lumber.
(3)	Original designs and working drawings made by pupil. Other designs collected by pupil.	Observations concerning wood turning in the local industries visited. Methods used, kind and quality of work turned out, amount of work done by an experienced man. Cost of wood turning.

SHEET METAL WORK.

(1) Laying out pattern, cutting, punching, bending.
New Tools—Square, scriber, dividers, punch, snips.
Problems—Match safe, box corners.

(2) Pattern drafting, riveting.
New Tools—Tinner's stake, rivet set, rivet hammer.
Problems—Flue thimble, taper pipe joint with side opening for square pipe.

(3) Soldering.
New Tools—Soldering iron, furnace or fire pot.
Problem—Cake cutters, dust trays, boxes.

(4) Turning edges—burs, seams, wired edges.
New Tools—Mallet, flat stake, round stake.
Problems—Funnel, measuring cup, square cake-pan.

(5) Brazing.
New Tools—Blow torch, tongs.
Problems—Sheet iron ferrule.

ART METAL WORK (COPPER AND BRASS).

(A) Flat Work.

(1) Laying out, drilling, cutting, and sawing outline.
New Tools—Hand drill, snips, jeweler's saw file.
Problems—Escutcheons, hinge tails, watch fob.

(2) Bending, folding.
New Tools—Mallet, vise, hammer.
Problem—Pad corners, box corners, hinges.

(3) Soldering.
New Tools—Soldering iron, blow pipe.
Problems—Match safe, toothpick holder, stamp box, picture frame.

(4) Riveting.
New Tools—Rivet set.
Problem—Lamp shade, sconce, book rack.

(B) Raised Forms.

(1) Shallow forms.
New Tools—Wooden blocks, sand bag, special stakes, raising and planishing hammers.
Problems—Desk trays, reflector for sconce (A) (4), top of box.

(2) Deep forms.
New Tools—Special stakes.
Problems—Small bowls.

(C) Decorative Treatment of Surface of Models in (A) and (B).

(1) Polishing.
(a) By hand.
(b) Cloth or felt buffing wheel.

(2) Hammering.

(3) Etching.

(4) Embossing.

(5) Coloring.
(a) With sulphur.
(b) With ammonia.
(c) Copper plating on brass.
(d) Silver solution.

PATTERN MAKING.

The prerequisites to this course are bench woodwork and wood turning. The work in elementary pattern making, therefore, should consist of well chosen exercises planned to illustrate the requirements of patterns, principles of construction, and methods of molding. After these exercises are completed and after some knowledge of molding is gained, patterns for projects to be finished in the machine shop should be required.

(A) Elementary Pattern Making.
- (1) Draft and shrinkage.
  Problems—Straight line simple ribbed pattern, slotted block.
- (2) Double shrinkage and finish allowance.
  Problems—One-piece pattern for cone pulley, face plate.
- (3) Simple split pattern with core prints, core box.
  Problem—Flanged pipe fitting.
- (4) Pattern requiring three-part mold.
  Problem—Double flanged pulley.
- (5) Match board pattern.
  Problem—Ring, letters.
- (6) Loose piece pattern.
  Problem—Square column with projections.

(B) Advanced Pattern Making.
- (1) Patterns for castings of small parts of machines (machine shop projects).
- (2) Patterns for large or complicated castings for machines (machine shop projects).

MOLDING AND FOUNDRY PRACTICE.

It is necessary that this work be very closely correlated with the pattern making, as each is dependent upon the other. Molds should be made of all completed patterns soon after the finishing coats are dry, in order to test the patterns.

(A) Molding.
- (1) Molds in half of two-part flash.
  Problems—Slotted block, face plate.

(2) Coping out drag.
Problems—Ring, wrench.
(3) Core making, use of cores.
Problems—Flanged pipe fitting.
(4) Three-part mold.
Problem—Double flanged pulley.
(5) Use of match board.
Problem—Pattern making problem (5).
(6) Molds of patterns having loose parts.
Problems—Pattern making problem (6).
(7) Making molds by use of sweeps.
Problems—Large ring of square cross section.
(8) Molding machine shop projects.

(B) Foundry Practice.
(1) Repairing and preparation of furnace and ladles.
(2) Charging of furnace.
(3) Drying molds.
(4) Core baking.
(5) Drawing off metal, pouring.
(6) Cleaning castings by hand.
(7) Use of tumbling barrels.
(8) Grinding castings.

In addition to pattern making exercises and foundry practice, there should be discussions, assigned readings, and written reports, on such related subjects as iron ore, preparation of ores; smelting—the reduction or blast furnace, fuels, fluxes, blasts, furnace designs; classification of iron—pig iron, Bessemer iron, basic iron; refining of pig iron; steel—crucible steel, open hearth steel, Bessemer steel; effect of silicon, sulphur, phosphorus, carbon, etc., on cast iron; methods of making malleable and chilled castings, steel castings, brass castings; machine molding. Commercial pattern shops and foundries should be visited, and the observations made should be discussed in class.

OUTLINE OF FORGE WORK.

(1) Drawing out, squaring with hammer.
New Tools—Forge, anvil, tongs, hammer, Hardy.
Problems—Exercises in lead or in iron.

(2) Drawing out round, swaging.
New Tools—Swage, sledge hammer.
Problems—Exercises.

(3) Pointing and bending.
New Tools—Horn of anvil.
Problem—Exercise, staple, meat hook.

(4) Twisting and bending, cutting stock.
New Tools—Blacksmith vise, cold chisel.
Problem—Gate hook, poker.

(5) Fullering, punching.
New Tools—Fuller, punch.
Problems—Eye bolt, hasp.

(6) Drilling, riveting, brazing.
New Tools—Center punch, drill and drilling machine, rivet set.
Problems—Exercise, ornamental bracket.

(7) Upsetting, forming.
New Tools—Heading tool.
Problem—Square bolt, hexagonal bolt.

(8) Splitting.
New Tools—Hot chisel.
Problems—Oar lock, ice hatchet, fork.

(9) Welding—Lap weld.
Problems—Exercise, ring, chain.

(10) Welding—Cleft weld.
Problem—Exercise.

(11) Case hardening.
Problems—Bolt head, any small forging.

(12) Tool forging.
Problems—Punch, cold chisel, lathe tools.

(13) Hardening and tempering.
Problems—Metal working tools, woodworking tools, bushings, drills.

(14) Review of processes in order to increase skill.
Problems—Forge tongs, carpenter's pinchers, draw-knife, ornamental projects.

(15) Repair of forge shop tools.

In addition to the necessary class instruction and demonstrations dealing with tools, operations, processes, etc., there should be shop talks on related subjects. These talks should be supplemented by assigned reading. Visits to local iron working industries should also be arranged, and the observations made should be discussed in class or should be written in the note-book. The subjects of shop talks should include the manufacture of iron and steel, the use of iron and steel in the industries, commercial methods of producing forgings in large numbers, decorative design applied to wrought iron.

MACHINE SHOP PRACTICE.

As it is not practicable to equip the machine shop with individual equipment of machine tools, the work cannot be arranged in the same way that any of the other shop work is. Proper sequence, from an educational point of view, as to operations and processes, can be followed only to a limited extent. Well planned exercises afford the most efficient means of giving the pupil a working knowledge of the tools, machines, and operations and processes used in general machine shop work. As soon as the pupils understand the operation of all machines and have developed sufficient skill, through the exercises, to do the work with reasonable speed and accuracy, projects should take the place of exercises. Better results can generally be obtained by the use of the group project instead of the class project. This is because the teacher can easily adapt the work to a small group of pupils who have been carefully selected from the class.

(A) Bench Work.
  (1) Chipping,
  Filing,
  Scraping.
  Key seat exercise.
  Cast iron exercise.
  (2) Fitting.
  (3) Assembling.
  (4) Use of taps and dies.—Exercise.

(B) Drilling and Boring.

(1) Laying out work,
Drilling within circle,
Guiding drill,
Countersinking and counterboring. } Exercises.

(2) Special drills, special uses of drill press.—Demonstration.

(3) Methods of clamping work in drill press.—Demonstration.

(C) Lathe Work.

(1) Plain cylindrical turning,
Taper turning,
Eccentric turning. } Exercises.

(2) Thread cutting.—Exercises.

(3) Face plate,
Angle plate, and chuck work,
Boring. } Exercises.

(4) Mandril work.

(5) Boring bar, use of steady rest, follower rest.

(6) Running, shrinking, and pressing fit.—Exercise may be part of 1 or 3.

(D) Shaper Work.

(1) Clamping and chucking work.—Demonstration.

(2) Plane surfaces at various angles.—Exercise.

(3) Cutting key ways.—Exercise.

(4) Special shaper work.—Demonstration.

(E) Planer Work.

(1) Clamping and chucking work,
Plane surfaces and slotting. } Exercises.

(2) Planing curved surfaces,
Planing dove-tail ways,
Special planer work. } Demonstrations.

(F) Machine Grinding.

(1) Surface grinding,
Selection of grinding wheels,
Wet and dry grinding. } Exercises.

(2) External and internal grinding.—Exercise.
(3) Tool grinding.

(G) Milling Machine Work.

(1) Cutting speeds and feeds.
Methods of holding cutters and work.
Principal milling operations.
} Demonstrations and Exercises.

(2) Indexing,
Special work.
} Exercises.

(3) Spur gear calculations,
Spur gear cutting.
} Exercises.

(4) Bevel gears,
Spur gears.
} Demonstrations.

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Frederick Post Co., Chicago, Ill.
Keuffel & Esser Co., Hoboken, N. J., and St. Louis, Mo.

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Walter Tips, Austin, Texas.

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Buffalo Forge Co., Buffalo, N. Y.
B. F. Sturtevant Co., Hyde Park, Mass.

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Francis Keil & Son, E. 163d St., New York, N. Y.
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Huey & Philp Hardware Co., Dallas, Texas.
Walter Tips, Austin, Texas.

Carver's Tools.

Hammacher & Schlemmer Co., New York, N. Y.
Mack & Co., Rochester, N. Y.
Miller Falls Co., Miller Falls, Mass.

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Cincinnati Tool Co., Norwood Station, Cincinnati, Ohio.
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W. T. & John Barns Co., Rockford, Ill.

Forges.

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Buffalo Forge Co., Buffalo, N. Y.
Oliver Machinery Co., Grand Rapids, Mich.
Champion Blower and Forge Co., Lancaster, Pa.

Foundry Equipment.

Hill & Griffith Co., Cincinnati, Ohio.
Ideal Mfg. Co., San Antonio, Texas.
Orr & Lockett Hardware Co., Chicago, Ill.

Furnaces—Melting, Tempering and Annealing.

American Gas Furnace Co., New York, N. Y.
Buffalo Dental Mfg. Co., Buffalo, N. Y.
Chicago Flexible Shaft Co., La Salle Ave., Chicago, Ill.

Gear Cutting Attachments for Lathes.

W. C. Young, Worcester, Mass.

Glue.

C. T. Bailey Co., Chicago, Ill.
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Pike Mfg. Co., Pike, N. H.
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Hammacher-Schlemmer Co., New York, N. Y.
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Lathe Tools.

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T. R. Almond Mfg. Co., Ashburnham, Mass.

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The Seneca Falls Mfg. Co., Seneca Falls, N. Y.

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Pipe Tools, Plumber's Tools.

Crane & Co., Dallas, Texas.
Walter Tips, Austin, Texas.

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American Woodworking Machinery Co., Rochester, N. Y.
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Oliver Machinery Co., Grand Rapids, Mich.
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Saws—Power Hack.

Millers Falls Co., Millers Falls, Mass.
Henry G. Thompson & Son Co., New Haven, Conn.

Shapers—Crank.

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Charles Besly & Co., N. Clinton St., Chicago, Ill.
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Charles Besly & Co., N. Clinton St., Chicago, Ill.

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St. Louis Basket and Box Co., St. Louis, Mo.
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Woodworking Tools.

Behering & Cartes, Houston, Texas.
Huey & Philp Hardware Co., Dallas, Texas.
Miller Falls Co., Miller Falls, Mass.
Sargent & Co., New Haven, Conn.
Stanley Rule and Level Co., New Britain, Conn., Norwood Station, Cincinnati, Ohio.
Walter Tips, Austin, Texas.

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